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PHASED-ARRAY RADAR

Innovative Sensing Experiment

2011 Scientist's Guide

Pam Heinselman and David Priegnitz, 28 April 2011

1. Introduction

A primary goal of the 2011 Phased-Array Radar Innovative Sensing Experiment (PARISE) is the demonstration and testing of innovative rapid-sampling techniques using the unique electronic scanning capabilities of the National Weather Radar Testbed Phased-array Radar (NWRT PAR; Zrnić et al. 2007). The system upgrades and rapid-sampling techniques developed through 2009 are described in Heinselman and Torres (2011). The scanning strategies implemented in 2010 are found in Heinselman et al. (2011), while software and signal processing upgrades are found in Torres et al. (2011).

Unique to the NWRT PAR is the capability to employ electronic adaptive scanning. This capability is implemented in ADAPTS (Adaptive Digital Signal Processing Algorithm for PAR Timely Scans), a baseline algorithm designed to provide more effective and efficient sampling of weather (Heinselman and Torres 2011). ADAPTS accomplishes this goal by sampling only the beam positions that the algorithm determines contain, or may soon contain, weather targets. When run, ADAPTS has been shown to reduce update times as much as ~30% (Heinselman and Torres 2011).

In 2010, scanning strategy update times were reduced by approximately 50% owing to the implementation of range oversampling (Curtis and Torres 2011). According to Curtis and Torres (2011), the range oversampling technique reduces update times while maintaining or even improving accuracy of estimates. The ADAPTS, when run in concert with range oversampling, can further reduce the update time, depending on storm coverage and location relative to the NWRT PAR.

In spring 2011 our data collection builds upon the techniques highlighted above. Our emphasis is on the demonstration and testing of scheduled adaptive scanning techniques that seek to minimize volumetric sampling time.

2. Scheduled adaptive scanning

Based on input from the weather community, the volumetric, temporal sampling requirement for a PAR system is 1-min (OFCM 2006). The implementation of range oversampling (Curtis and Torres 2011) makes this requirement achievable while maintaining data quality, dense low-altitude sampling, and improving vertical sampling near the radar. These vertical sampling characteristics are accomplished by modifying the operational VCP 12 scanning strategy (REF) to contain five additional tilts above 19.5° (Table 1). The VCP sampling parameters (Figs. 4 and 5) maximize the Nyquist velocity, 29.3 m s^{-1}, and produce a maximum range of 448 km at the 0.5° elevation. Given the VCP's parameters (Table 1), the update time for sampling a 90° sector is ~55 s.

Though a 55-s update time exceeds the suggested 1-min volumetric sampling requirement, our goal is to capitalize on the NWRT PAR's capability to minimize volumetric update time. In spring 2011, four sampling techniques may be employed to further reduce volumetric update time: 1) running ADAPTS, 2) minimizing the VCP's maximum elevation angle based on storm range, 3) setting the maximum range based on storm coverage, and 4) scheduling interlaced scanning. The impacts of these sampling adjustments are as follows:

1. ADAPTS reduces the number of active beam positions (based on storm coverage).
2. Inputting the *minimum* storm range into the user interface reduces the VCP's maximum elevation angle, and the update time of the surveillance scan performed by ADAPTS.
3. Inputting the *maximum* storm range into the user interface will either change the PRT, or change the waveform from split-cut to uniform, which significantly reduces the update time (occurs when maximum range is ~120 km).
4. When volumetric sampling times are 50s or less, interlaced scanning at low elevation angles may be added to the table by changing the maximum height of the 2nd Enhance VCP 12 entry (section 3.4). The resulting cumulative update time must be less than 1 min. This action will produce more rapid updates at the included elevation angles.

The implementation of these sampling adjustments requires the use of new interactive tools in Radar Control Interface and understanding of the weather scenarios in which they are most useful. The next section provides example scenarios and instructions for making the needed scanning adjustments.

3. Scheduled Scanning Scenarios

Before we dive into the scenarios, let's review how we begin a data collection session.

Begin Data Collection with System Tab

☐ Input your name into the Notes tool on the RCI. Also input the focus of the data collection.
☐ Turn on IQ and Moment data archiving and validate the date
Note: By default the RCI creates the proper folder name using the system time on the client computer. Verify that the date is correct, adjust accordingly.
☐ Enable ADAPTS-2 Processing

Click on Scan Tab

☐ Turn on transmitter and point antenna in desired direction
☐ Turn on Edit Mode
☐ Load desired table (EnhancedVCP12 or EnhancedVCP12X2 (two entries in scan table))
☐ In scan table, set a repeat count for each active table entry
☐ Send Table
☐ Deselect Edit Mode
☐ Start Scan Control

Visualize sector and storm motion

☐ Click on “Storm Motion”, located below the scan table on the right-hand side

☐ Input storm’s Az, Ran, Motion, and direction antenna is pointed

Use the display to assess the how well the storms of interest are being sampled. Note how soon the antenna may need to be turned (track assumes linear storm track over 2-hrs). Make any needed antenna adjustments.

Antenna Adjustment

☐ Stop Scan Control, Adjust direction, Start Scan Control

During Data Collection

☐ Use the Notes tool when:

1) There is hardware, air conditioning, or other failure assoc. w/ the PAR
2) Significant weather is occurring or a warning has been issued in the domain

Following Data Collection

☐ Write summary of data collection and e-mail that to Pam

☐ Send e-mails to:

Dan Suppes, dan.suppes@noaa.gov, so that he knows to archive the data.
Kiel Ortega, Kiel.Ortega@noaa.gov, so that he knows if a damage survey will be needed.

3.1 Storms moving away from PAR

When all storms are moving *away from* the PAR, update time may be minimized by adjusting the *minimum* range.

☐ Stop Scan Control

☐ Click on Range/Height Plot

☐ Input *minimum range* of storms

Results in change in Ele(H), the maximum elevation used, RanMin, and update time entries in table

Rmin and Ele(H) are displayed in Range/Height plot as dark yellow lines

☐ When Scan Control is Ready, click on “Send” in Table Control

☐ Restart Scan Control

NOTE: You can edit the scan table during active. However, at this time you CANNOT send updates to the RTC while scanning is active. You must FIRST STOP SCANNING and then send the updated scan table.

3.2 Storms moving toward PAR

When all storms are moving *toward* the PAR, update time may be minimized by adjusting the *maximum range* of storms.

☐ Stop Scan Control
☐ Click on Range/Height Plot
☐ Input *maximum range* of storms
    Results in change in RngMax entry and update time in table
    All PRTs in scanning strategy are limited to sample within maximum range
☐ When Scan Control is Ready, click on "Send" in Table Control
☐ Restart Scan Control

3.3 Storms moving parallel (N or S) to PAR

When all storms are moving parallel to the PAR, depending on the situation update time *may be* minimized by adjusting both the *minimum* and maximum range.

☐ Stop Scan Control
☐ Click on Range/Height Plot
☐ Input *minimum and maximum range* of storms
    Results in change in Ele(H), the maximum elevation used, and RanMin entries in table
    Results in change in RngMax entry and update time in table
    All PRTs in scanning strategy are limited to sample within maximum range
☐ When Scan Control is Ready, click on "Send" in Table Control
☐ Restart Scan Control

3.4 Interlaced Scanning

When storms have the potential to become tornadic, update times at low elevations may be prioritized by scheduling additional sampling at low altitudes.

☐ Stop Scan Control
☐ Upload EnhancedVCP12X2 if not currently in use
☐ Click on Edit Mode
☐ Click second entry in table
☐ Select Range/Height Plot
☐ Input the *maximum height* you want to sample
    The Range/Height plot will draw a red line at that height
    The scan table will show the new update time

FYI: Update time for lowest two elevations is ~6.2 s
    Update time for lowest four elevations is ~18 s
See Fig. 5 for other update times.

☐ Check if the update time plus the volumetric update time is less than 60 s
☐ If combined update times > 60 s, adjust height or abort.
☐ If combined update times < 60 s, when Scan Control is Ready, click on "Send" in Table Control
☐ Restart Scan Control

References

Curtis, C. D., S. M. Torres, 2011: Efficient range oversampling processing on the National Weather Radar Testbed. Extended Abstracts, *27th Conference on Interactive Information and Processing Systems (IIPS)*, Seatlle, WA, USA, Amer. Meteor. Soc., 13B.6.

OFCM, 2006: Federal research and development needs and priorities for phased array radar. Rep. FMC-R25-2006, Interdepartmental Committee for Meteorological Services and Supporting Research, Committee for Cooperative Research Joint Action Group for Phased Array Radar Project, 62 pp. [Available online at www.ofcm.gov/r25-mpar/fcm-r25.htm.]

Heinselman, P. and S. Torres, 2011: High-temporal resolution capabilities of the National Weather Radar Testbed phased-array radar. *J. Applied Meteor*. *Climatol*., **50**, 579–593.

Heinselman, P. L., S. M. Torres, D. Zaras, and H. Lazrus, 2011: 2010 Phased-array radar innovative sensing experiment. Extended Abstracts, 27*th Conf. Interactive Information Processing Systems*, Seattle, WA, Amer. Meteor. Soc., 12B.4.

Heinselman, P. L., D. L. Priegnitz, K. L. Manross, T. M. Smith, and R. W. Adams, 2008: Rapid sampling of severe storms by the National Weather Radar Testbed Phased Array Radar. *Wea. Forecasting*, **23**, 808–824.

Torres, S., C. Curtis, I. Ivić, D. Warde, E. Forren, J. Thompson, D. Priegnitz, and R. Adams, 2011: Software and signal processing upgrades for the National Weather Radar Testbed phased-array radar. Preprints, *27th Conf. on Interactive Information and Proc. Systems* (IIPS), Seattle, WA, Amer. Meteor. Soc., 12B.3.

Data Collection Responsibilities
2 May – 19 June 2011

During your week, you and your partner are responsible for collecting data with the NWRT PAR when severe storms are expected and/or occurring within 150 km of the radar. Our goal is collect continuous data on a storm of interest --- be sure not to turn the radar a lot -- from supercell to supercell – rather pick a storm and stick with it unless it begins to weaken significantly. Pick your storm based on location (nearest to radar) and environmental conditions in the area.

Monday – Sunday Schedule

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
2 May	Pam and Adam					
9 May	Pam and Ric					
16 May	Dave and Adam					
23 May	Pam and Dave					
30 May	Ric and Jen					
6 June	Ric and Adam					
13 June	Dave and Jen					

Operating the NWRT Phased Array Radar

David Priegnitz

The National Weather Radar Testbed (NWRT) Phased Array Radar (PAR) is controlled by a software package called the Radar Control Interface (RCI). The RCI package consists of a single server application, referred to as the RCI server, and one or more client applications, referred to as the RCI client(s). Both the RCI server and client applications are written in Java and can be run on workstations supporting Java 1.5 and above. The RCI server currently resides on a workstation running Linux. However, it could run on other systems (e.g., Windows XP) as long as Java is available on the host computer. Current RCI client applications run on a variety of systems.

The radar operator interfaces with the RCI client to monitor and control the PAR. This document provides instructions on how to start an RCI client from a workstation and outlines typical procedures on how to set up and run scans. It also describes some of the problems one may encounter and how to resolve them.

Starting the RCI Client

There are several ways in which the RCI client application can be started. On a typical configured workstation there should be an icon (shortcut) in the main display window (look in task bar). The icon should have the label "RCI Client" associated with it. To start the RCI client application "double click" on the icon or "right click" and select "Open". After a few seconds a new window is displayed. A sample RCI window is shown in Fig. 1.

By default, a new RCI client application is launched as non-controlling. This means that it cannot control, only monitor, system activity. Along the top of the RCI client application window are a set of menu selections and below that a group of tabs. The default tab that is selected is the System tab. This is the tab that one will normally have selected most of the time during operations. It provides most of the status and control objects one will need to successfully operate and monitor the PAR. If another RCI client is controlling the radar one should see something other than “None” to the right of the “Controlling Client” label. NOTE: When an RCI client is non-controlling, most control objects (i.e., pushbuttons, menus) are desensitized (inactive).

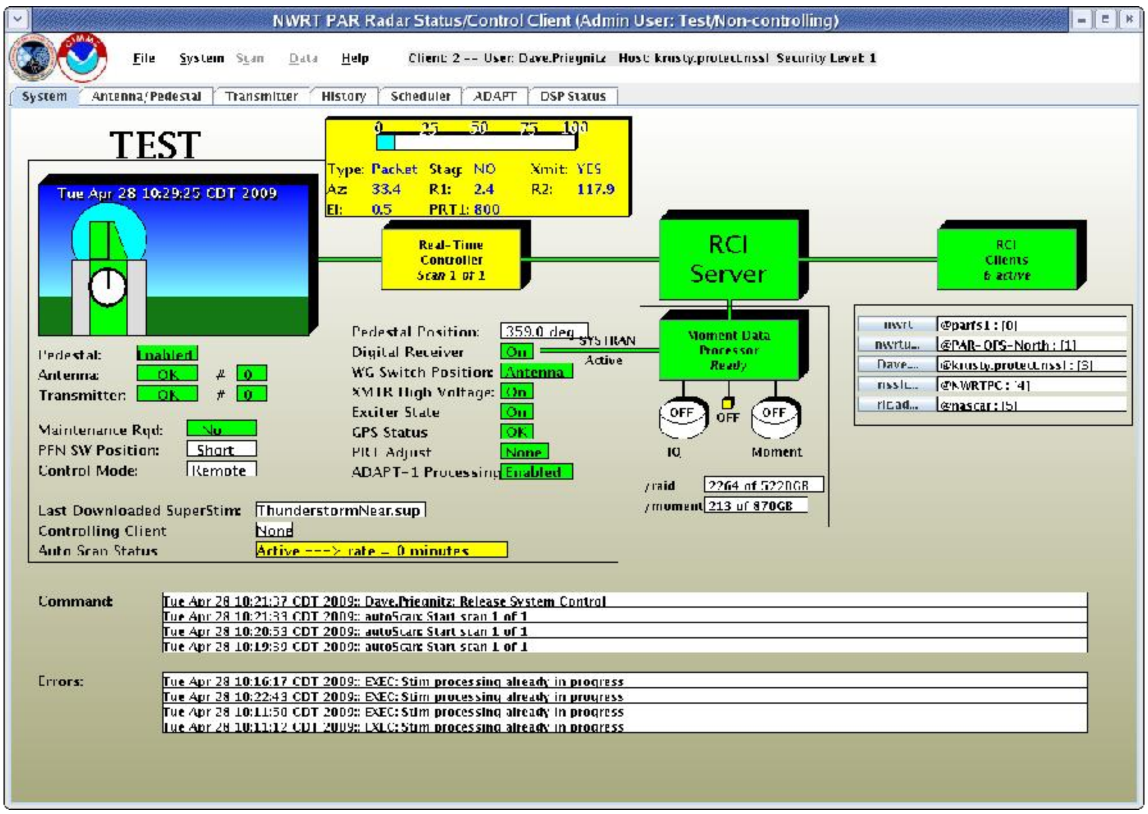


Figure 1: RCI Client System Panel View (non-controlling)

Controlling the PAR

In order to send control commands to the PAR a controlling client is required. In order to do that, select the “System” menu item, navigate to the “Control” sub-menu and then select “Request”. If another RCI client currently has control one is prompted as to whether to take control from that client (this can be done only if the user has equal or higher control authority; this information is defined in a security file at the RCI server). If control is allowed, the RCI client display changes. An sample controlling RCI client window is displayed in Fig. 2.

One should notice that the background color inside the RCI client application window has changed color (background color of the menu region is red) and the window label has changed from “Non-controlling” to “Controlling”.

The status of the system interlock switch will determine whether one can operate the PAR. If the region below the radome graphic is red (and the text to the right of “Pedestal:” label is “Disabled”), then data collection is not permitted. The transmitter high voltage cannot be turned on and the waveguide switch cannot be switched to the antenna. In addition, the pedestal position cannot be changed. This status indicates that someone has turned the safety interlock switch to the disable position at the PAR building or WSR-88D building. The usual reasons are either someone is inside the PAR building doing maintenance or giving a tour. Data cutouts have been added to the Real-Time Control (RTC) software so the PAR is no longer disabled when someone is working up in the KOUN tower. However, data cannot be collected in the cutout regions. The current active cutout regions are: azimuths 52-56 degrees at elevations < 6 degrees (KCRI) and azimuths 96-106 at elevations < 10 degrees (KOUN).

NOTE: It may be possible to get the KOUN cutouts removed during operations when severe weather is in the area. Contact Dave Priegnitz or Ric Adams for more information.

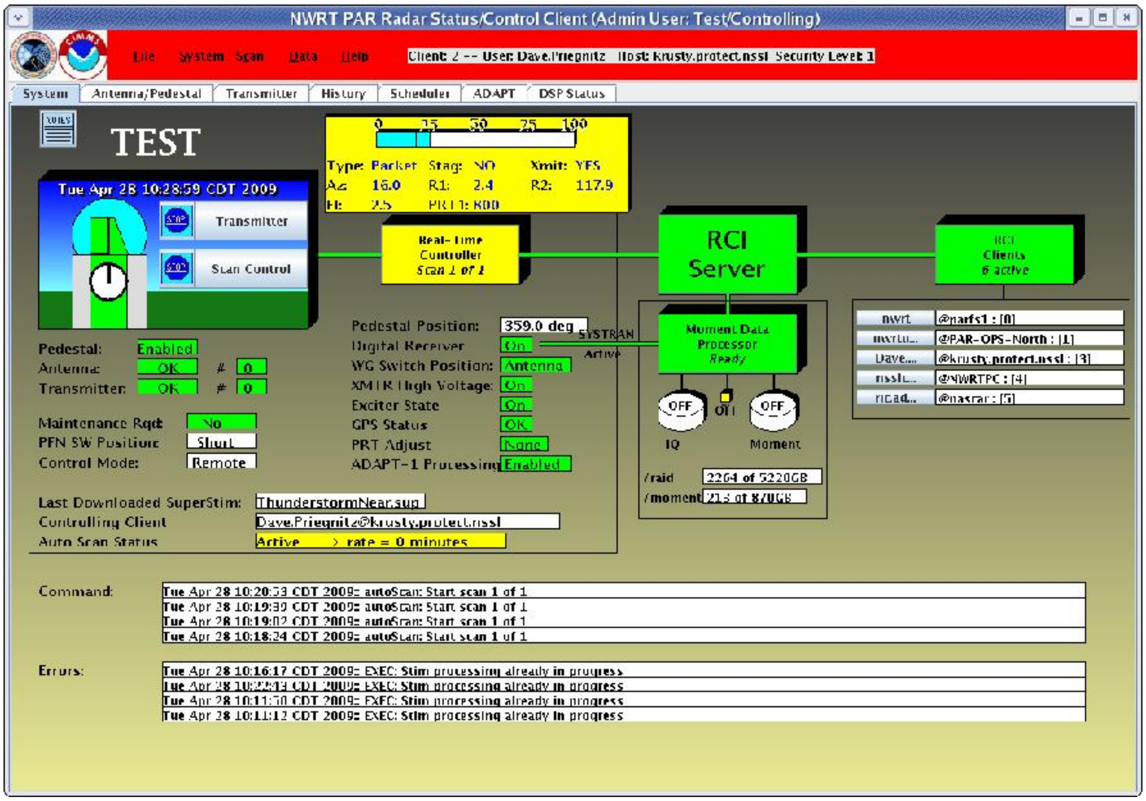


Figure 2: RCI Client System Panel View (controlling)

If the safety interlock switch is in the "enabled" position, then the region below the radome graphic is green (and the text to the right of the "Pedestal:" label is "Enabled"), data collection is allowed.

The bottom third of the System panel is set aside for displaying log and error messages. The last 4 command messages are displayed in one group and the last 4 RTC error messages are displayed in the other (if any exist).

Directing the Antenna

The first step before starting data collection is to determine the direction to point the antenna. Since the NWRT PAR has a single face, up to a 90 degree azimuth sector can be scanned without having to move the antenna. To the right of the "Pedestal Position:" label is the direction the antenna is pointing (at bore site). Normally the antenna is parked at north (0 degrees) so the stairs from the second floor to the opening to the third floor are aligned. Wherever the antenna is pointed, scanning is done relative to this position. For instance, if one is running a 90 degree sector scan, then the actual azimuths will be +/- 45 degrees from this position.

To move the antenna select the "P" button beneath the radome object. A popup window is displayed in which an azimuth angle (0-360) can be specified. Selecting "Accept", directs the antenna to move to that position. The RTC object (box to the right of the PAR facility graphic labeled "Real-Time Controller") status should indicate "Pedestal Position" (background color yellow). When the move is complete the RTC object status should indicate "Ready" (background color green).

Selecting a Scan Strategy (Super Stimulus)

The first thing one normally wants to do after getting control access is to select a scanning strategy. Until recently, scanning strategies have been defined by special files, referred to as "Super Stimulus Files". A Super Stimulus file contains information about which stimulus (scan control) files to run. A Stimulus file contains information such as which azimuth and elevation angles to scan, the PRT and number of pulses for each position, etc. An individual pulse or dwell is individually defined by a stimulus record (this is what is actually executed by the real-time software at the PAR) and a stimulus file contains a sequence of these that define a scan.

Collecting data using a Super Stimulus is performed from the System Panel. To define a Super Stimulus either select the "SuperSTIM" button above the Real-Time Controller (RTC) box or select the "SuperSTIM" item in the "File" menu. A popup window is displayed from which either a project name or full directory path on the RCI server to one or more Super Stimulus file is selected. From the list of project names, choose the one named "PARISE 2010". The following Super Stimulus names are defined:

VCP	# Tilts	Waveform	Time
EnhancedVCP12	19	Split cut < 8	55 secs
Oversampled_VCP.sup	22	Split cut < 6	2 min
Oversampled_VCP_within_120km_only.sup	22	Uniform	1.4 min
Tornadic.sup	4+22	Split cut	3.3 min
Tornadic_outside_120km_only.sup	2+22	Split cut	2.73 min
Tornadic_within_120km_only.sup	4+22	Uniform	2.3 min

Once a Super Stimulus file is chosen the RCI server sends it to the PAR Real Time Controller (one may briefly notice the label in the RTC object change to "Processing Super STIM" with the background yellow). After the Super Stimulus is loaded and ready, the text to the right of the "Last Downloaded SuperStim:" label should reflect the file chosen. Also, once a Super Stimulus is loaded, the Scan Control object to the right of the PAR facility object should be visible.

Selecting a Scan Strategy (Scan Table)

To support future adaptive scanning, a new method has been developed for users to define up to 10 active scan strategies. Named "Scan Table", this method uses a table containing a list of scan strategies for data collection instead of a single scan strategy (i.e., super stimulus). Selections are provided to load individual scan strategies to a specific location in the table and modify them. Selections are also provided to save the contents of the scan table or load a previously saved scan table. Unlike Super Stimulus scanning, properties of each scanning strategy can be modified dynamically to better fit the active weather scenario. Each of these properties will be described further in this section.

A new panel, Scan Panel, has been added to the RCI client to support Scan Table scanning. It is displayed by selecting the “Scan” tab between the “System” and “Antenna/Pedestal” tabs. A sample Scan panel is presented in Fig. 3. The Scan Panel is broken up into two halves: scan table and scan control.

Scan Table

The upper half of the Scan Panel contains a table along with a number of selections to modify it. In addition, two groups of buttons are provided beneath the table to control a single scan table entry (Scan Control) and the entire scan table (Table Control).

In the “Scan Control” group four buttons are provided: Delete, Load, Properties, and Send. Only the Properties button can be selected whether or not the user is in Edit Mode.

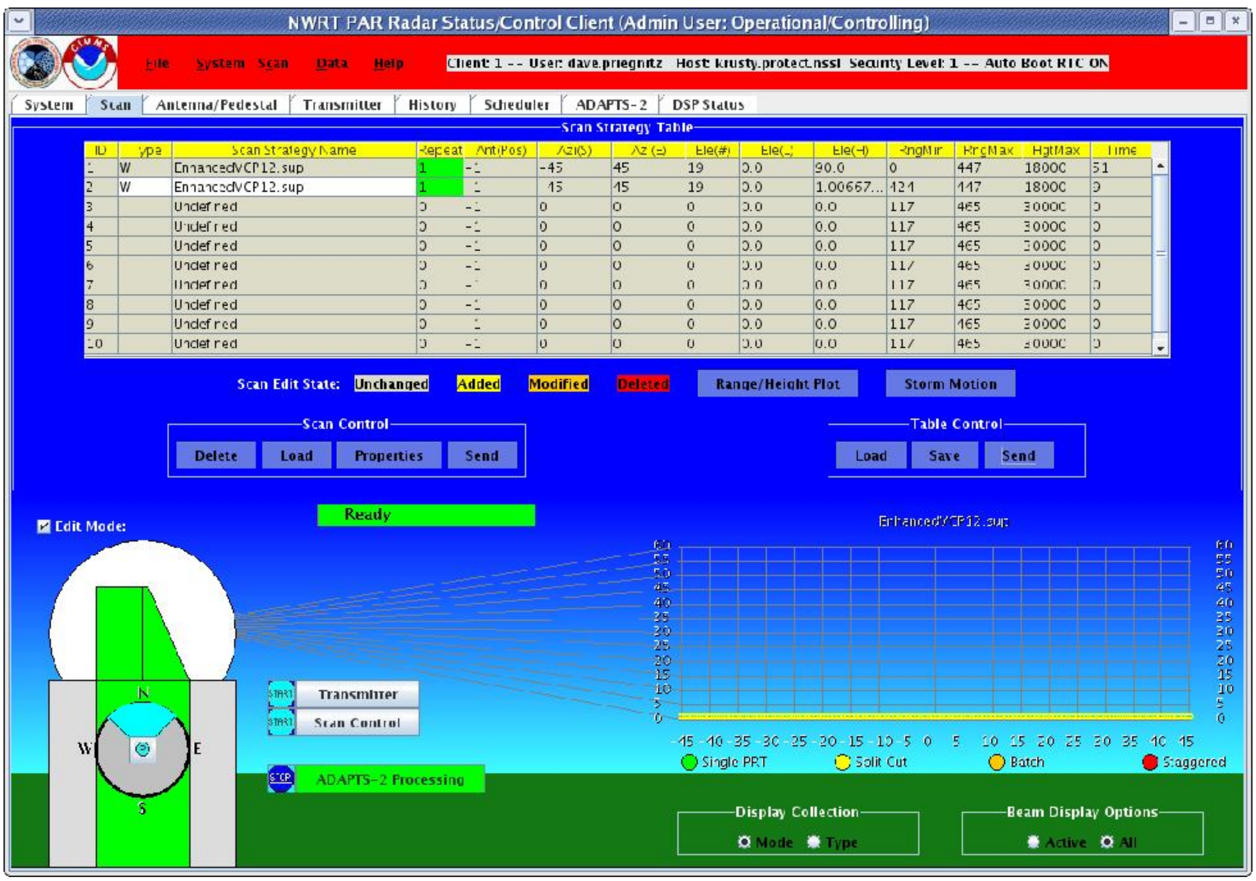


Figure 3: Sample Scan Panel

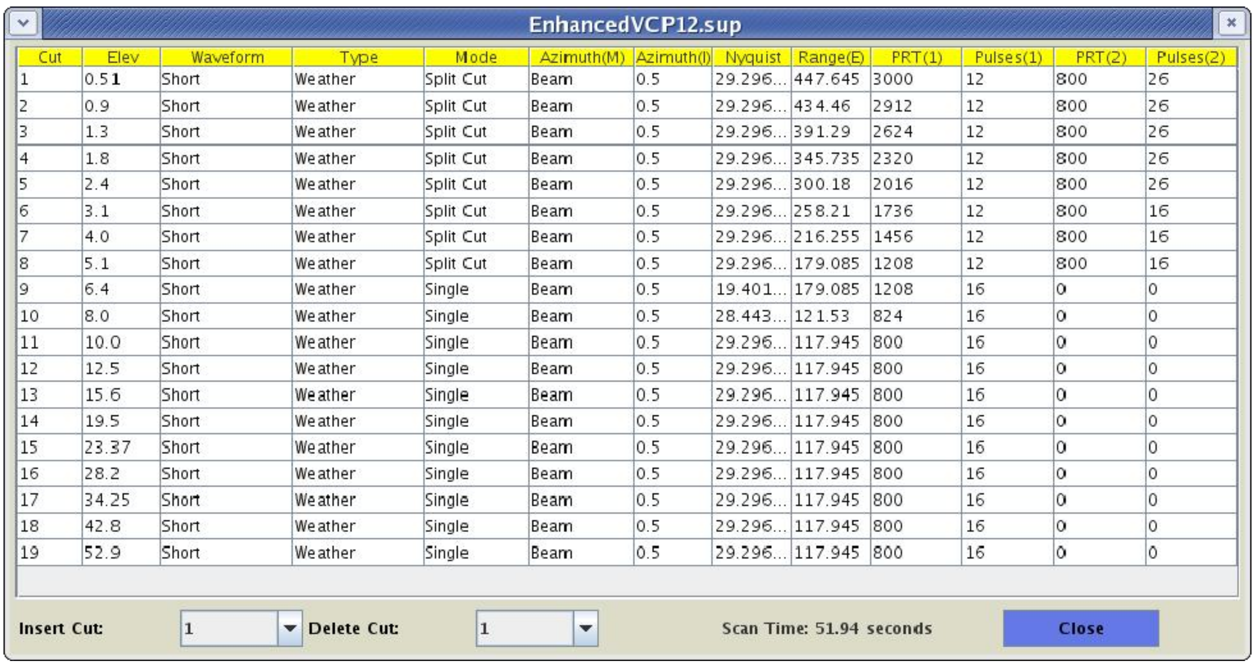
In edit mode, the “Delete” button removes the highlighted scan. When a scan is deleted, the area beneath the scan table ID turns red and the scan name is changed to “Undefined”. In non-edit mode this button is desensitized.

In edit mode, the “Load” button activates a pop up window from which the user selects a scan strategy from a list. It may take several seconds for the new scan to be loaded, so have patience.

When a new scan is loaded, the area beneath the scan table ID turns yellow. In non-edit mode this button is desensitized.

In both edit and non-edit mode the "Properties" button displays a window containing detailed scan information for the highlighted scan strategy. A sample Scan Properties window is presented in Fig. 4. The scan properties are presented in a table with each row representing an elevation cut. Properties for each cut can be modified only by the controlling client. These properties include: elevation angle, waveform (long or short), scan type (weather or tracking), cut mode (single, split cut, batch), azimuth mode (constant beam or beam relative), azimuth beam spacing, PRT(s), and pulse count(s). In addition, elevation cuts can be added or deleted. Any changes are internal and do not affect the original scan strategy that was loaded into the scan table. If you want to save any changes you must save the entire scan table.

In edit mode the "Send" button sends the highlighted scan strategy to the RTC. If the scan strategy was modified and the edits not previously saved, a pop up window is displayed asking whether the changes are to be saved first. Again, if you want to save any edits you must save the entire scan table.



Cut	Elev	Waveform	Type	Mode	Azimuth(M)	Azimuth(I)	Nyquist	Range(E)	PRT(1)	Pulses(1)	PRT(2)	Pulses(2)
1	0.51	Short	Weather	Split Cut	Beam	0.5	29.296...	447.645	3000	12	800	26
2	0.9	Short	Weather	Split Cut	Beam	0.5	29.296...	434.46	2912	12	800	26
3	1.3	Short	Weather	Split Cut	Beam	0.5	29.296...	391.29	2624	12	800	26
4	1.8	Short	Weather	Split Cut	Beam	0.5	29.296...	345.735	2320	12	800	26
5	2.4	Short	Weather	Split Cut	Beam	0.5	29.296...	300.18	2016	12	800	26
6	3.1	Short	Weather	Split Cut	Beam	0.5	29.296...	258.21	1736	12	800	16
7	4.0	Short	Weather	Split Cut	Beam	0.5	29.296...	216.255	1456	12	800	16
8	5.1	Short	Weather	Split Cut	Beam	0.5	29.296...	179.085	1208	12	800	16
9	6.4	Short	Weather	Single	Beam	0.5	19.401...	179.085	1208	16	0	0
10	8.0	Short	Weather	Single	Beam	0.5	28.443...	121.53	824	16	0	0
11	10.0	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
12	12.5	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
13	15.6	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
14	19.5	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
15	23.37	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
16	28.2	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
17	34.25	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
18	42.8	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
19	52.9	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0

Figure 4: Sample Scan Properties display

Two additional buttons are available beneath the scan table: "Range/Height Plot" and "Storm Motion". These buttons launch applications that can be used to modify scan properties. Both buttons are selectable regardless of RCI control and edit modes.

1) Range/Height Plot

Selecting the "Range/Height Plot" button displays the "NWRT Scan Range/Height Diagram" window. It is used to display graphically the elevation cuts contained in the highlighted scan strategy. It is also used to define a minimum and maximum range and storm height which in conjunction can be used to reduce scan time. A sample window is presented in Fig. 5.

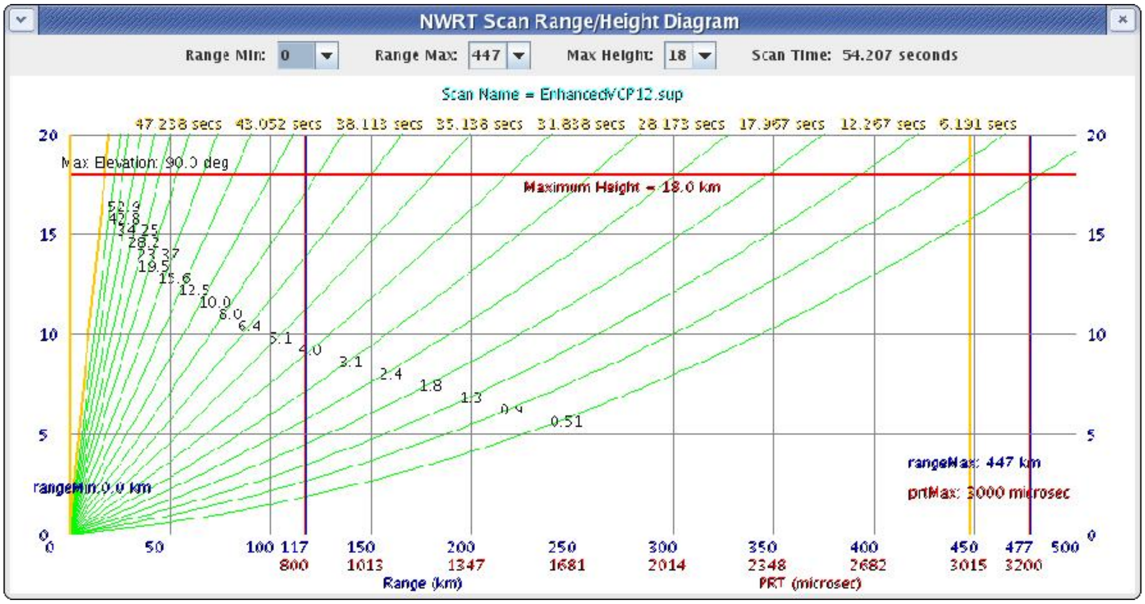


Figure 5: Sample NWRT Scan Range/Height Diagram display

Across the top of the window is a set of selections to set the minimum and maximum ranges along with a maximum height. The minimum range and maximum height are used together to determine an upper elevation cut off value. By increasing the minimum range and/or lowering the maximum height one can eliminate unnecessary elevation cuts, thus reducing overall scan time. A plus 1 rule has been implemented which keeps one elevation cut above the threshold. Fig. 6 illustrates the effect of setting a higher minimum range on the active elevation angles and scan time.

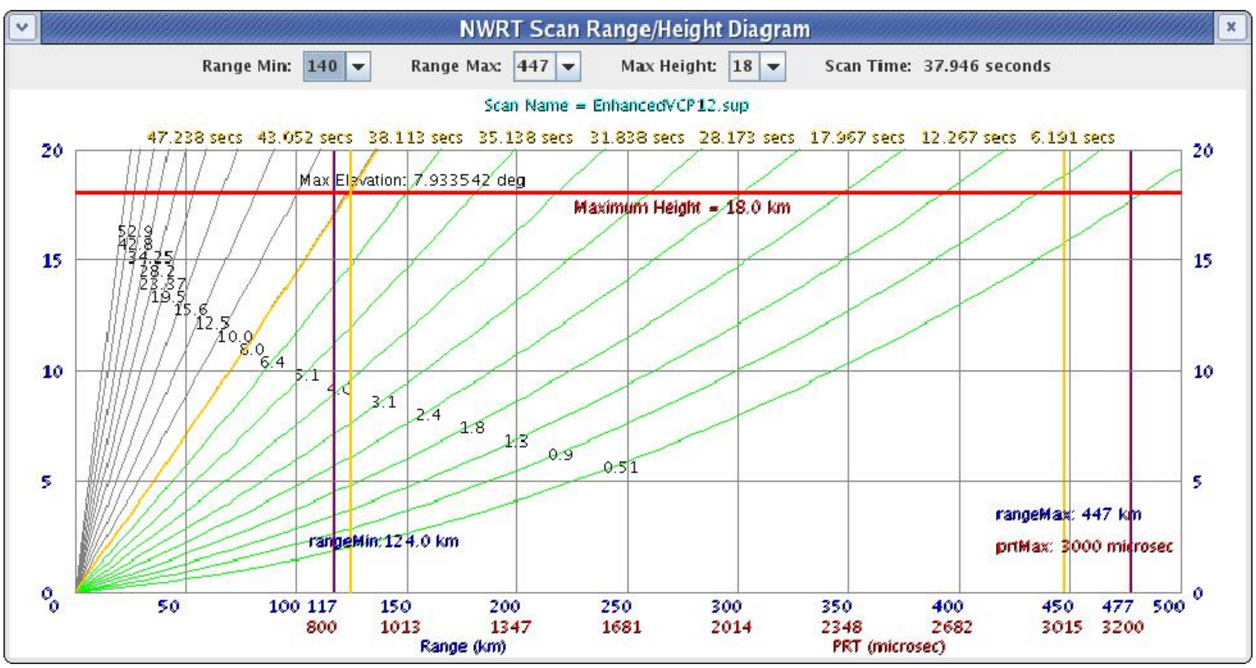
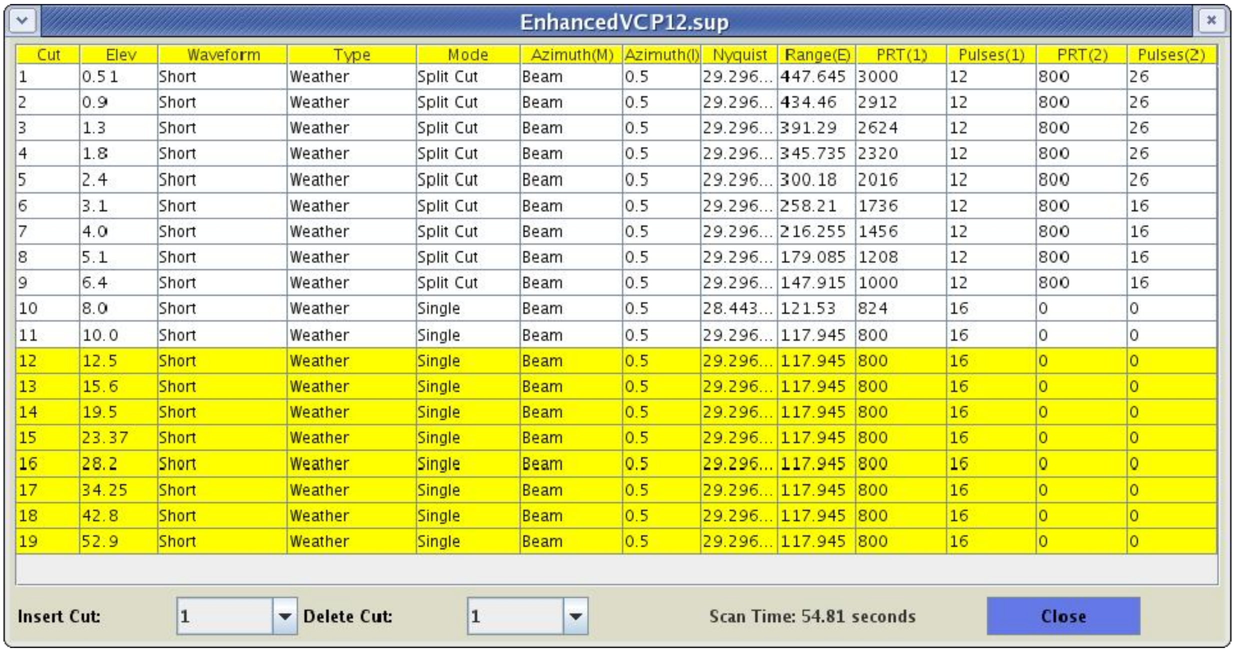


Figure 6: Sample NWRT Scan Range/Height Diagram display with minimum range set to 140 km

In this example, using the plus 1 rule will set the upper elevation cutoff at 10.0 degrees.

Setting the minimum range and maximum height also affects the appearance of the Scan Properties window. Elevations that are “deactivated” are highlighted in yellow. Fig. 7 shows a sample display with “deactivated” elevation cuts.



EnhancedVCP12.sup

Cut	Elev	Waveform	Type	Mode	Azimuth(M)	Azimuth(I)	Nyquist	Range(E)	PRT(1)	Pulses(1)	PRT(2)	Pulses(2)
1	0.51	Short	Weather	Split Cut	Beam	0.5	29.296...	447.645	3000	12	800	26
2	0.9	Short	Weather	Split Cut	Beam	0.5	29.296...	434.46	2912	12	800	26
3	1.3	Short	Weather	Split Cut	Beam	0.5	29.296...	391.29	2624	12	800	26
4	1.8	Short	Weather	Split Cut	Beam	0.5	29.296...	345.735	2320	12	800	26
5	2.4	Short	Weather	Split Cut	Beam	0.5	29.296...	300.18	2016	12	800	26
6	3.1	Short	Weather	Split Cut	Beam	0.5	29.296...	258.21	1736	12	800	16
7	4.0	Short	Weather	Split Cut	Beam	0.5	29.296...	216.255	1456	12	800	16
8	5.1	Short	Weather	Split Cut	Beam	0.5	29.296...	179.085	1208	12	800	16
9	6.4	Short	Weather	Split Cut	Beam	0.5	29.296...	147.915	1000	12	800	16
10	8.0	Short	Weather	Single	Beam	0.5	28.443...	121.53	824	16	0	0
11	10.0	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
12	12.5	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
13	15.6	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
14	19.5	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
15	23.37	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
16	28.2	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
17	34.25	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
18	42.8	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0
19	52.9	Short	Weather	Single	Beam	0.5	29.296...	117.945	800	16	0	0

Insert Cut: 1 Delete Cut: 1 Scan Time: 54.81 seconds Close

Figure 7: Sample Scan Properties display with "deactivated elevation cuts

2) Storm Motion

Selecting the "Storm Motion" button displays the "NWRT Storm Motion Diagram" window. It is used to display graphically where a storm will move in a two-hour period provided a specified initial location and motion vector. In addition, the direction of a 90 sector representing the antenna can be manipulated to help define an antenna position that will maximize storm coverage and minimize antenna repositioning. A sample window is presented in Fig. 8.

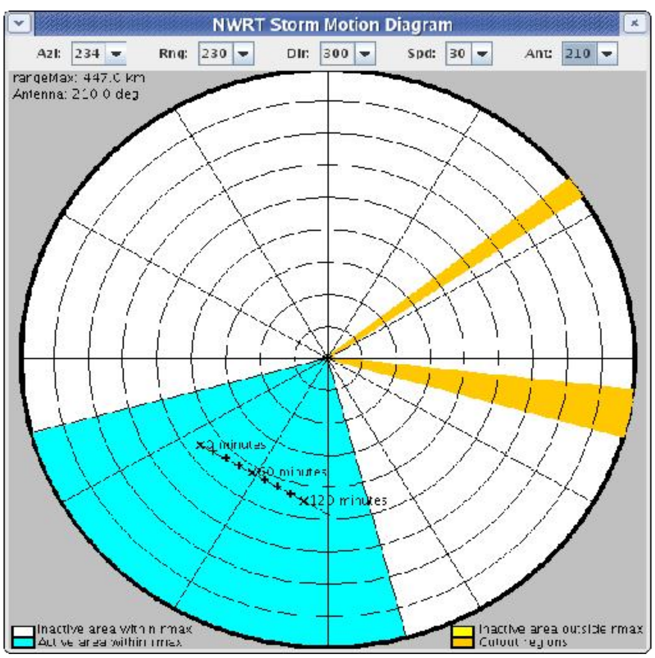


Figure 2a: Sample NWRT Storm Motion Diagram display

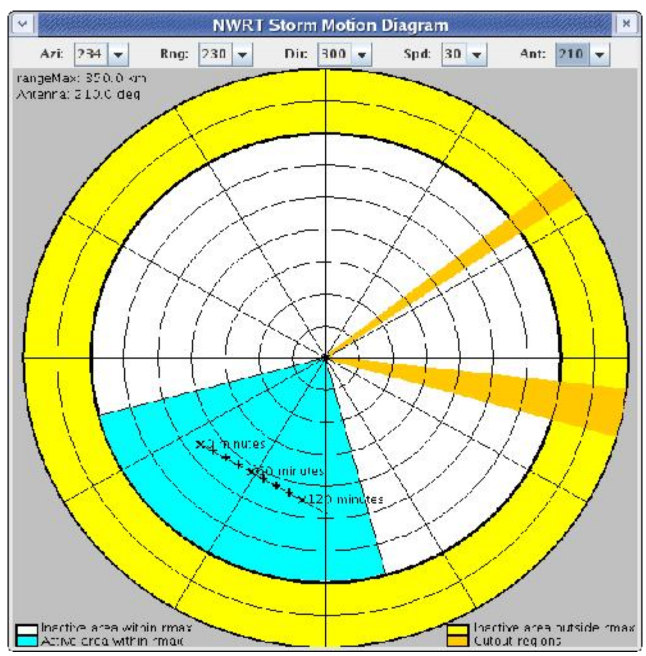


Figure 8b:Sample NWRT Storm Motion Diagram display with maximum range set to 350 km

One can further reduce scan time by adjusting the maximum range. Using the Range Max selection in the NWRT Scan Range/Height Diagram one can increase/decrease the maximum

PRT used for the long pulse in split/batch cuts. In the example presented in Fig. 8b, if no storms existed beyond 350 km then the maximum range could be reduced accordingly, further reducing the scan time. Areas shaded in yellow indicate locations which are beyond the maximum scan range. Areas shaded in orange are inside the KCRI and KOUN cutouts and cannot be scanned (it is possible that the KOUN cutout may deactivated this spring for data collection events).

To improve the display of storm tracks near the radar, pressing the left mouse button will increase the magnification factor by increments of 1. When the magnification factor exceeds 4 it is reset to 1.

<u>Scan Control</u>

The bottom half of the Scan panel is used for scan control and status. It has a similar look as the ADAPTS-2 panel with some extra scan control features. It displays graphically the status of the radar along with the status of the active scan strategy. When in controlling mode, buttons are available to move the pedestal ("P" button inside pedestal graphic), toggle on/off the transmitter, start/stop scanning, toggle on/off ADAPTS-2 processing. Most of these controls are identical to the controls for running Super Stimulus files from the System Panel window and will not be repeated here. The main difference is that these selections control the scan table.

The "Edit Mode" check box can be selected by both controlling and non-controlling clients. If the check box is selected only the beams for the scan strategy highlighted in the scan table are displayed in the right half of the Scan Control region. If the check box is unselected, the beams for the active scan strategy are displayed. If you want to monitor the progress of active scanning you will want the check box unselected.

In this example (Fig. 3), the scan strategy "EnhancedVCP12.sup" is defined twice. The first instance has all elevation cuts active while the second has only elevation cuts below ~1 degree active.

Recording Time Series (IQ) Data

During operations the operator is responsible for controlling IQ data recording. IQ recording should always be assumed active unless directed otherwise. In the RCI client System tab window, IQ data recording can be controlled by selecting the IQ disk object below the Moment Data Processor (MP) object. If IQ recording is inactive, the IQ disk object color is white with the word "OFF" displayed below it. To turn on IQ recording select the disk object and at the prompt, enter a directory path for the IQ data files to be written to. Good practice is to use a directory name containing the date, such as "PAR_20100401" (PAR_yyyymmdd) so it will be easier finding specific data after data collection. At this point, the IQ disk object color should change to green with the word "ON" displayed below it. Currently, IQ data are written to a RAID with a capacity of 12 terabytes. The amount of space used is displayed below the IQ and Moment disk objects. If the RAID usage exceeds 90%, the IQ disk object color is yellow. If the number falls to less than 1% the color changes to red.

Keep in mind that IQ files tend to be very large. Currently, the MDP application is responsible for archiving data. If IQ recording is active, the MDP starts a new IQ file when the user starts a scan. If the user specified a repeat count > 1 before starting the scan then each subsequent scan is written to the same file until the repeat count is satisfied. It is imperative that one doesn't set the repeat count very large (or unlimited) when IQ data recording is active. Otherwise, the resulting IQ data file will be extremely large and unmanageable. A good rule of thumb to follow is not to have more than 10 minutes of IQ data in a single file. For scans that take ~1 minute to run the repeat count should be set to 10 or less. If the scan time is 30 seconds, then a repeat count of 20 would be OK.

It is estimated that the current RAID will hold approximately 480 hours (20 days) worth of IQ data. During inactive weather, IQ data will be copied off of the RAID so space can be freed up as needed. It is unlikely that the RAID will fill up unless an extended stretch of active weather prevents data to be copied from it.

It is expected that IQ data recording will be active at all times during operations. After an MDP restart or reboot make sure that this is on!

Recording Moment Data

Recording moment data is similar to recording IQ data. However, each moment data scan (volume) is stored in a separate file. Since moment data files are typically several orders of magnitude smaller than its corresponding IQ file, we shouldn't have to worry about not having enough space on the RAID to save them. Moment data are stored in the new WSR-88D message 31 format. Several software tools have been updated to support this new format. When moment data recording is turned on, one is prompted for a directory name where the moment data will be written into. Good practice is to use a directory name containing the date, such as "PAR_20100401" (PAR_yyyymmdd) so it will be easier finding specific data after data collection.

It is expected that moment data recording will be active at all times during operations. After an MDP restart or reboot make sure that this is on!

Running a Scan (Super Stimulus)

Once a new Super Stimulus is loaded and data recording is turned on, the "Scan Control" object should be selected and a scan repeat count entered using the values defined previously (In the IQ recording section).

To start a scan select the "Start" icon to the left of the "Scan Control" object. If the waveguide position is not already set to "Antenna" and the transmitter high voltage is not turned on, one is prompted as to whether the transmitter is to be turned on first. One can always turn the transmitter "on" prior to starting a scan by selecting the "Start" icon to the left of the Transmitter object.

A few seconds after commanding a scan to start, the label in the RTC object should change from "Ready" to "Scan 1 of X", where "X" is the scan repeat count. The RTC object background color changes from green to yellow. In addition, a window should popup above the RTC object containing information on the stimulus that is currently being executed and a progress bar indicating the percentage of the scan that has been completed. When all of the stimulus commands have been processed the RTC object label should change back to "Ready" and the object background color to green.

To tell if the scan was successful one should look at the WDSSII display and determine whether the PAR related windows have been updated.

Since time series and moment archiving are assumed active, when the scan starts, the Moment Processor Data (MDP) object background color changes to yellow with a status of "Archive

Busy". When a scan set (1 or more volumes) is completed, the scan control buttons are inactive for a brief amount of time until the archive process flushes its buffers and closes all open files. At this time, the Moment Data Processor object background color changes to green with a status of "Ready". This usually takes several seconds after the last scan has completed.

NOTE: Moving the antenna does not require reloading the Super Stimulus and turning on IQ and moment data recording. However, the scan repeat count gets reset to 1 which means you will need to run one scan and then set the scan repeat count as you did before.

Stopping a Scan

If a multiple repeat count was specified and one wants to stop scanning select the "Stop" icon to the left of the "Scan Control" object. The scan will stop when the current volume is completed. Normally one will want to stop a scan when weather conditions warrant moving the antenna to a new position and not wanting to wait until the repeat count has been satisfied.

If one wants to immediately stop a scan without waiting for the current volume to complete then go to the Scan menu and select the "Abort" object.

NOTE: On an abort command, the transmitter is also turned off and any recorded IQ and moment files are incomplete. Unless there is a problem with data quality, or if one can wait for the current volume to complete, use the "Stop" scan command.

Auto Scan (Super Stimulus)

If you want to run scans continuously or at specific time intervals, the RCI supports an auto scan feature where you have control over the scan frequency. To activate auto scan you select the "Scan Control" object, select a frequency from the drop down menu to the right of the "Timed Scan" label, set the radio button to its left and then select "Accept". After you select the "Start" scan button scanning will start and repeat until you either stop the scan as described in the last section or by unsetting the radio button in the "Scan Control" object menu (when the current scan has completed).

PRT Adjust

In some instances, radial velocities in regions of interest may be obscured. The RCI client provides a selection, called "PRT Adjust", which allows the operator to change the short PRT in split and batch cuts to move the unambiguous range outward in 10 kilometer increments (up to 40 km). One can activate the "Adjust Unambiguous Range" menu by selecting the hot spot to the right of the PRT Adjust label. From the menu the operator chooses one of the allowed range factors. To turn this feature off either choose "None" from the menu or reload the superStim file.

ADAPT-1 Processing

An algorithm has been developed to identify scan beams which contain significant echo and integrate this information into a scan table which is used to tell the RTC which beams are to be executed and skipped in the next scan. The purpose of this algorithm is to reduce scan time by eliminating beams in regions where there isn't significant weather.

When the RTC is operating, a label is displayed in the RTC section of the System window named "ADAPT-1 Processing". To the right of this label is an object which can be used to enable/disable the ADAPT-1 algorithm.

If the ADAPT-1 algorithm is enabled and a scan is active, selecting the "ADAPT" tab will display the ADAPT window. The ADAPT window displays graphically all beams in the scan and information about whether they are active or inactive. A sample ADAPT window is displayed in Fig. 9.

<u>It is expected that ADAPTS will be active at all times during operations. Only disable if it is malfunctioning.</u>

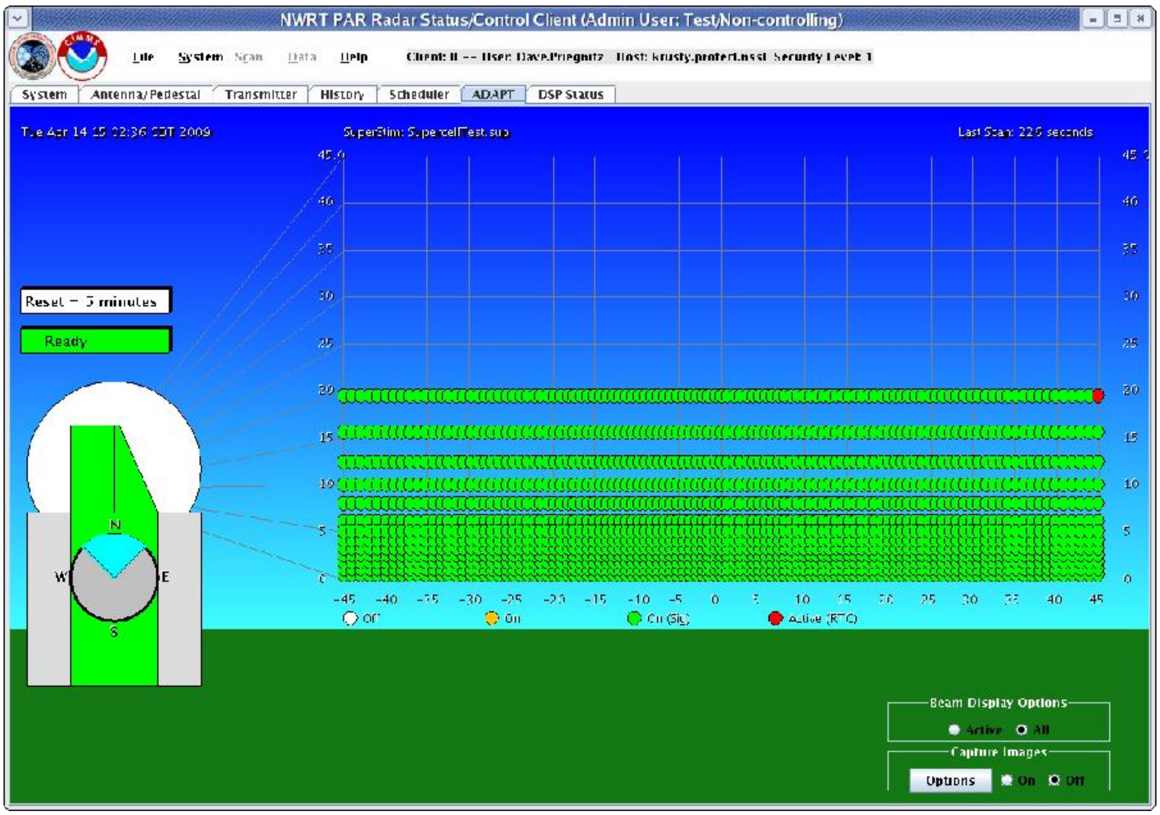


Figure 9: Sample RCI Client ADAPT display

Autoboot RTC

Although recent RTC code updates have improved RTC reliability, it periodically locks up. When this happens the operator needs to reboot the RTC. To minimize down-time during operations, an autoboot feature is available at the RCI so when the RCI server detects a problem communicating with the RTC, it will automatically reboot it. To turn this feature "on" Select "Turn Autoboot RTC ON" from the "System" dropdown menu. To turn this feature "off" select "Turn Autoboot RTC OFF" from the "System" dropdown menu.

In addition to the RTC lockups, the digital receiver may experience problems which result in garbage being output during a scan. In many cases the RTC detects this and sends an error message to the RCI server. If Autoboot RTC is "on", the RTC will be automatically rebooted by the RCI server upon receipt of the message.

Troubleshooting

Real Time Controller

There are several conditions in which you will need to reboot the Real Time Controller (RTC). These conditions include:

1) The Real Time Controller object in the System panel turns red.
2) An active scan hangs (progress bar in the System panel does not update).
3) Reflectivity display in WDSS-II incorrect.
4) You notice a message in the Error section of the System panel about the digital receiver strobing.

If the RTC needs to be rebooted, select the Real-Time Controller object. A popup window is displayed containing some status information and control objects. Select the "Start" icon (leave the Reboot checkbox selected). A prompt asking to confirm the request to reboot the RTC is presented. Select "Yes".

One should immediately notice that the RTC object has changed from green to either yellow (status label "REBOOT") or red (status label "DOWN"). It will take a little over 30 seconds for the RTC computer to be rebooted and the RTC software loaded. Once the reboot is complete and the RTC software loaded the RTC software performs some initialization and an antenna test. This should take another 30 seconds or so. When the RTC is ready the RTC object should be green (status label "Ready"). Follow the same steps previously defined for running a scan (the RTC maintains a copy of the last Super Stimulus that was downloaded so it won't have to be reloaded before starting a scan).

Note: If you turn Autoboot RTC "on" then the RCI server should be able to reboot the RTC without any operator intervention. In most instances, if the auto-reboot RTC feature is enabled the reboot will occur automatically. However, there are situations where the auto-reboot feature will not work and you will have to manually reboot the RTC.

If the RTC will not recover after a reboot then contact one of the troubleshooters: Dave Priegnitz, Ric Adams, Mark Benner.

Moment Data Processor

If you notice that the Moment Data Processor object or the DSP Status tab turns red, then you may need to restart the Digital Signal Processing (DSP) software.

1) If the Moment Data Processor status is "Down" then a restart is in order.
2) If the Moment Data Processor status is "Read Error", then you will need to issue an abort scan, wait for the read error to clear, then restart scanning.
3) If the DSP Status tab is red then open the DSP Status window and determine which component (s) caused the problem. If you are rebooting the RTC then the "SYSTRAN LINK" alert will indicate a fault for a few seconds while power is recycled at the RTC. It should clear once the RTC software starts coming up. Right now the "EP to RTC State" alert indicates a fault all of the time; just ignore it (for RCI clients running in Linux, this alert doesn't cause the DSP Status tab to turn red. On some windows RCI clients it does). All other faults will require a DSP software restart.

To restart the DSP software select the Moment Data Processor object. A popup window is displayed containing some status and control objects. Select the "Start" icon (do not select the

Reboot checkbox at this time). A prompt asking to confirm the request to restart the MDP is presented. Select “Yes”. The MDP restart process could take several minutes to complete. ***If the MDP object background color doesn't change to green (status “Ready”) then the MDP will need to be rebooted. Contact one of the troubleshooters if this needs to be done.***

Keeping Notes

During operations it is a very good practice to keep good notes on what is going on. In the upper left corner of the System tab window is an icon labeled “NOTES”. If one selects this icon a window is displayed in which you can enter free text. Comments can be made about significant weather, radar problems, etc. This information is added to a database which is accessible in the Scheduler panel (Fig. 10). To view notes from current and previous times move the cursor over a table item in the Scheduler tab window.

A popup window is displayed showing all text for that time and some additional properties about that time (the owner of the information at that time and contact information; usually the owner is the controlling client at the time the note was created).

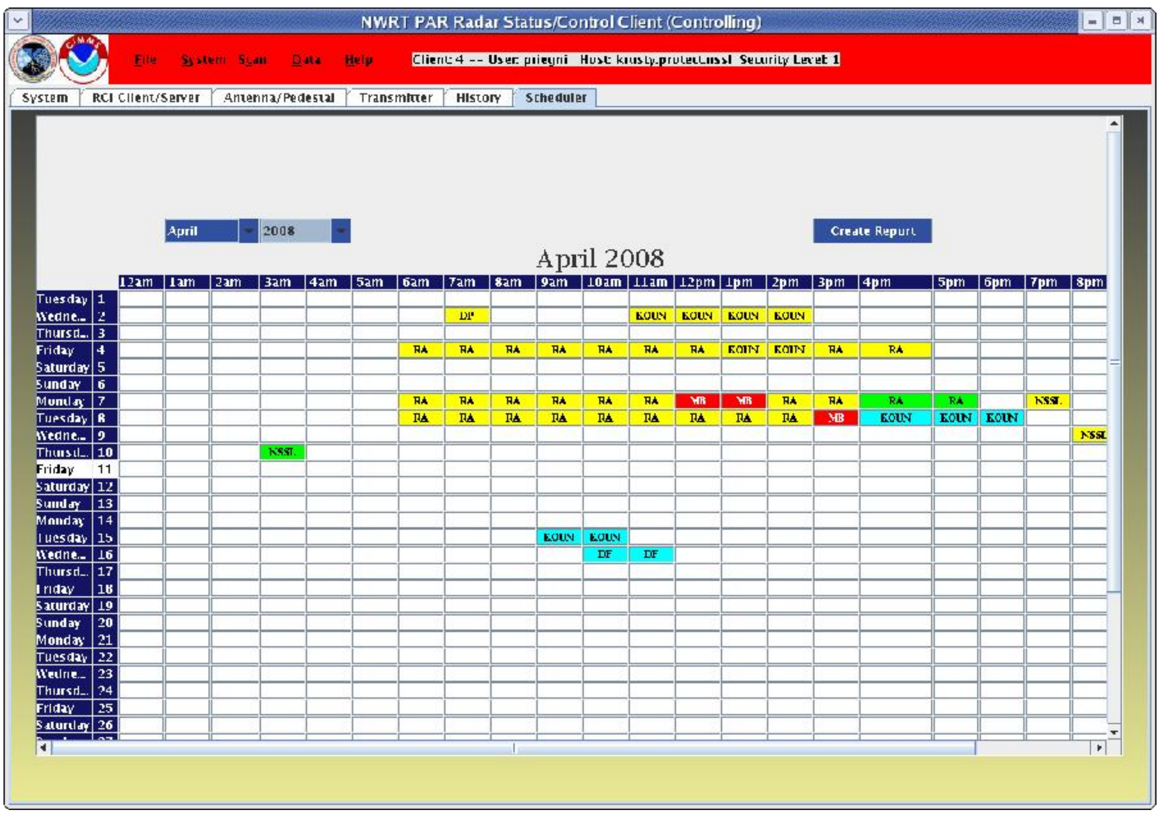


Figure 10. Sample Scheduler Panel Display